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USE OF COAL COMBUSTION PRODUCTS IN VIRGINIA

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INTRODUCTION

The American Coal Ash Association (ACAA) promotes the use of coal combustion products (CCPs) in applications that are commercially effective, technically proven, and environmentally sound (Industry Newswatch, 1994). The ACAA reported that the total production of all coal combustion products in 1999, in the United States, was 107,074,879 short tons (ACAA, 2001, written communication). This total tonnage includes fly ash, bottom ash, boiler slag, and flue gas desulfurization (FGD) material. The total of fly ash, a finely divided residue that results from the combustion of pulverized coal that is blown into a burning chamber (dry and ponded), was 62.7 million tons; about 20.8 million short tons were utilized primarily in flowable fill, structural fill, waste stabilization, and mining applications. Heavier bottom ash is utilized in all these applications as well as for snow and ice control, blasting grit, and roofing granules. Almost 90 percent of boiler slag is utilized for blasting grit and roofing granules, and almost 69 percent of FGD (synthetic gypsum), is utilized in wallboard (ACAA, 2001, written communication). All of these uses are described in detail in the publication by the Office of Technology Applications (1995).

ASH IN VIRGINIA

Coal-fired power plants in Virginia produced about 2.1 million short tons of coal combustion products in 1999 (Figure 1). In the early to mid 1990s, several companies, including Agglite Corporation, in the Hampton Roads area, and ReUse Technology, Inc., R. T. Construction Sciences Division, located in Chester, Virginia, were utilizing CCPs for various construction applications (Figure 2). Agglite utilized fly ash from the Chesapeake plant of Dominion Virginia Power, mixed with portland cement to produce a flowable fill for sub-base under concrete slabs. Bottom ash, from this plant and power plants around Richmond, was and continues to be sized and marketed for concrete cinderblock in eastern, central, and northern Virginia. ReUse Technology, Inc. has marketed several products for use in flowable fill and structural fills, some up to 40 feet-high, in central Virginia.

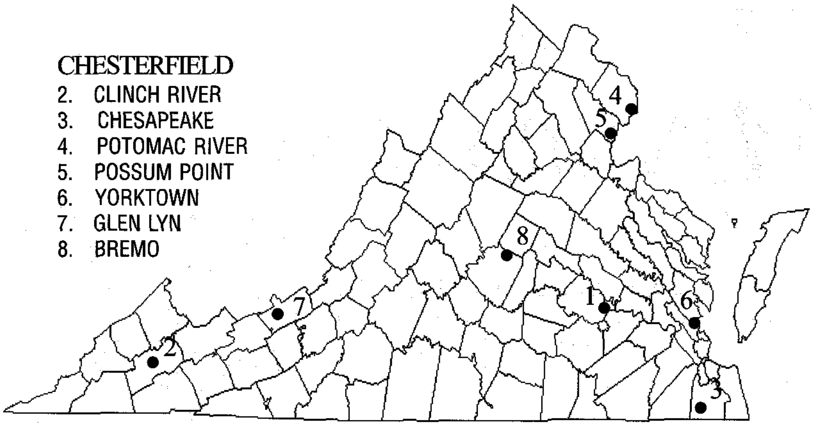

Figure 1. Location of major coal-fired power plants in Virginia.

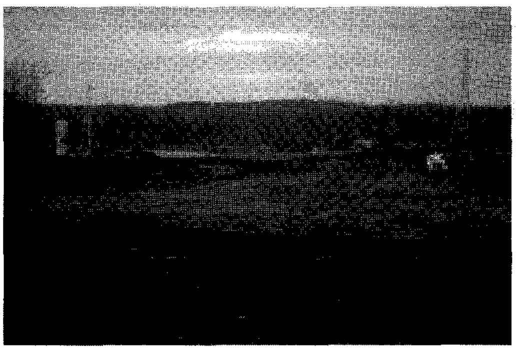

Figure 2. Plant site of ReUse Technology, Inc., located near the Town of Chester.

Figure 3. Target Department store, sitting on 250,000yd^3 of Xtra Fill™, Town of Midlothian.

Their Xtra Fill™ is a blend of fly ash, a cementitious binder (lime kiln dust), and water that is combined in a pug mill; the amount of water added depends on the application. Cognetrix Energy, Inc., which operates power plants in nearby Richmond and Hopewell, daily truck fly ash to ReUse's plant site. The lime-kiln dust is obtained from Global Stone Chemstone Corporation in Strasburg, Virginia.

An example of the use of Xtra Fill™ was the construction of the Target Department store on Midlothian Turnpike and Branchway Road near Midlothian, Virginia (Figure 3). The 25-acre Target site was very wet, and grade design required an average of 6 feet of fill in January, 1997. Local stone contained too much moisture. About 2 to 5 inches of Xtra Fill™ was disced into a wet, silty clay subsoil. The excess moisture was absorbed by the product, and then the site was stabilized with additional Xtra Fill™. A total of 250,000 cubic yards of the product was utilized. The material was so effective that only 20 days were lost above the 15 days of rainfall (Sweet, 1998).

Another ReUse site for structural fill is Warwick Road in Richmond, where the Virginia Department of Transportation widened and regraded the road. The structural fill contains about 200,000 cubic yards of Xtra Fill™, up to 40-feet thick (Figure 4). Another construction site on Midlothian Turnpike, Chesterfield Marketplace, was a large, low, wet area that required a structural fill or a sub-base material—a thin layer to the south and about four feet toward the north—to level the area. A total of about 80,000 cubic yards of fly ash was used.

ReUse Technology, Inc., beginning in the mid-1990s, also obtained fly ash from the wet and dry ponds ("Walden Pond") of the Dutch Gap (Chesterfield) plant of Dominion Virginia Power. ReUse operated a pug mill, at the dry pond area, and produced structural-fill material (Xtra Fill™) on-site. They trucked fly ash from the dry pond area to their Chester plant to produce EZ Fill™. EZ Fill™ is produced by mixing fly ash with cement and water; this flowable fill is delivered in a cement truck. The product is a cost-effective construction backfill delivered in a slurry state and hardens to provide superior load-bearing characteristics in sub-base uses. Another example would be a private residence where the site soil is a plastic clay with moderate to high shrink/swell potential. Ordinarily a contractor would undercut and backfill with crushed stone or concrete. Voids in the stone accumulate water. Softening the underlying soil was a concern as well as the additional weight. Using 60 cubic yards of EZ Fill™ (flowable fill) the foundation could be poured in three hours at a cost about half of using crushed stone.

Figure 4. Forty-foot structural fill of Xtra Fill™ under Warwick Road, City of Richmond.

In the mid-1990s, Agglite Corp., on site at the Chesapeake plant of Dominion Virginia Power, mixed bottom ash with portland cement, surfactant foam, a dry catalyst, and accelerators (Sweet, 1994). These ingredients combined with water were mixed with a screw auger, and the material was then pelletized. It was a cold-bonded process, with no external heat. Only the heat of hydration released by the combination of bottom ash and cement is utilized. The "manufactured aggregate" is spherical and light (58 lbs/ft^3) and has physical properties necessary to meet the three basic ASTM specifications for lightweight aggregate. The lightweight aggregate was stored in on-site silos. Markets for this product were in the manufacturing of concrete cinderblock in Virginia and North Carolina. This company presently has a small plant at the Dutch Gap (Chesterfield) plant of Dominion Virginia Power, where they process the bottom ash to produce a lightweight material that is also used in concrete cinderblock. The material is marketed to Vulcan Construction LP (formerly Tarmac America) in the City of Richmond and to a block company in Charlottesville. Bottom ash from the Cogentrix Energy, Inc., in Richmond is marketed to the block plant of Betco in Manassas, Virginia.

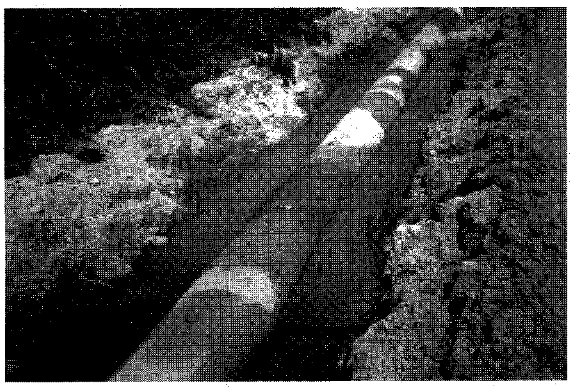

Figure 5. Flowable fill used to encapsulate a concrete pipe, City of Norfolk.

Figure 6. Flowable fill used as sub-base material under concrete slabs for vertical support beams, Harbor Park Stadium, City of Norfolk.

Fly ash from the Chesapeake plant of Dominion Virginia Power also was used by Agglite Corp. as a compacted sand substitute as well as a flowable fill (Figure 5). The flowable-fill material is a combination of fly ash and cement, which are mixed with water in a concrete truck and then applied on-site like concrete. A large quantity of flowable fill (9,000 yd^3) was used as a sub-base material under concrete slabs for vertical support beams at the Harbor Park Stadium in downtown Norfolk (Figure 6).

Dominion Virginia Power burns only coal at its Yorktown plant, and, in the early- to mid-1990s, ReUse Technology, Inc., utilized much of the ash produced by the Yorktown plant in the Hampton Roads area. At that time, Dominion was also storing both bottom ash and fly ash on a 45-acre site about 2 miles south of the power plant. The ash was transported by truck, compacted, and stored in 3-acre "cells" underlain by a 5-foot layer of bentonite clay. Each cell contains about 90,000 cubic yards of ash. After the ash is dumped and rolled, it hardens. The filled cell is covered with a 2-foot layer of soil and grass is planted. The final product is essentially a 20-foot high, long, flat plateau. Approximate cost of preparing a cell to store the ash was half a million dollars (L. Johnson, 1993, personal communication). By the end of 2000, five cells were complete and a sixth cell was being prepared. In early 2001, Dominion Virginia Power applied to the Virginia Department of Environmental Quality to modify their ash permit in order to "mine" the ash cells as needed. VFL Technology, West Chester, PA has been contracted to manage the ash hauling operations from the Yorktown plant. Some ash is being hauled to Gloucester Materials Co. The fly ash is mainly used for structural fill, where the ash is mixed in a pug mill with lime-kiln dust; some also is mixed with cement and water in a concrete truck to produce a flowable fill.

At the Clinch River plant of American Electric Power, in Russell County, Virginia, about 70 percent of the fly ash and 80 percent of the bottom ash are successfully marketed. Fly ash is sold through the ISG Group to concrete batch plants in Lebanon and Abingdon. Ash is also hauled, under contract, to Georgia and Florida for fine aggregate in concrete. The remaining fly ash is hauled off-site and stored. Bottom ash is pumped off-site from the plant into settling ponds. An independent company (Appalachian Products) wet screens and sizes (3/8" and less) the bottom ash for use in concrete block, produced at regional brick and block plants. Some of the bottom ash (200-250 short tons per day) that is stored in settling ponds is extracted, dried, and trucked to the Bristol Solid Waste Facility in Bristol, Virginia for use as daily cover (R. Peppler, 2001, personal communication) (Figure 7). At the Clinch River plant very light cenospheres (hollow silica-alumina glass beads), a component of the bottom ash, float on the settling ponds (Figure 8). The light, cream colored space-age material are derived from power generation. They are intermittently marketed for use in automobile body fillers, paints and coatings, plastics, and roof coatings. Other uses are in aerospace materials, marine hulls, oilfield cements, piping, and adhesives.

Figure 7. Daily cover of bottom ash at Bristol Solid Waste Facility, City of Bristol.

Figure 8. Cenospheres on surface of bottom ash settling pond, Clinch River plant of American Electric Power Company.

In 2001, some of the fly ash from the stockpile at the Chesapeake plant of Dominion Virginia Power was mixed with lime in a pug mill, and hauled by Construction Products Management, Inc., for use in a large structural fill, on the ramps to the southern by-pass around Suffolk, Virginia (Figure 9). More than 250,000 short tons of ash will be utilized at this site.

Other potential uses of fly ash include the filling of borrow pits and reclaiming surface coal mines. Borrow pits, in the Coastal Plain province of Virginia, are lined with clay, filled with ash, returned to their original contour level, covered with soil, and seeded. Buchanan (1993) noted that consideration was being given to utilizing fly ash in reclaiming surface coal mines. The Virginia Department of Environmental Quality began formulating regulations that would ban fly ash or allow only a percentage to be returned to the Southwest Virginia coalfields, according to the volume of coal mined in individual counties. In 1995, new state guidelines were passed by the Virginia General Assembly that allowed by-product fly ash to be placed only on permitted land sites and only for useful reasons.

Another potential use of fly ash was initiated in the Chesapeake Bay area of eastern Virginia in late 1994. This study involved the combining of fly ash, bottom ash, and portland cement into pellets (ping-pong-ball to grapefruit size) for use as an environmentally acceptable substitute for natural shell in oyster-reef restoration (Industry Insight, 1994). The results of the laboratory study indicated that the pellets, a mixture of about 88 percent fly and bottom ash and 12 percent Type II portland cement, are environmentally safe and facilitate the settlement, attachment, and growth of oysters (Andrews and others, 1997). When a large volume of pellets (about 1500 tons) were produced, quality control of the pellet size became a problem, and the stack of pellets did not provide the interstitial space necessary for oyster habitat. Presently, the accessibility of ash, the cost of portland cement, and the necessary quality control are concerns. Future studies should focus on making fly-

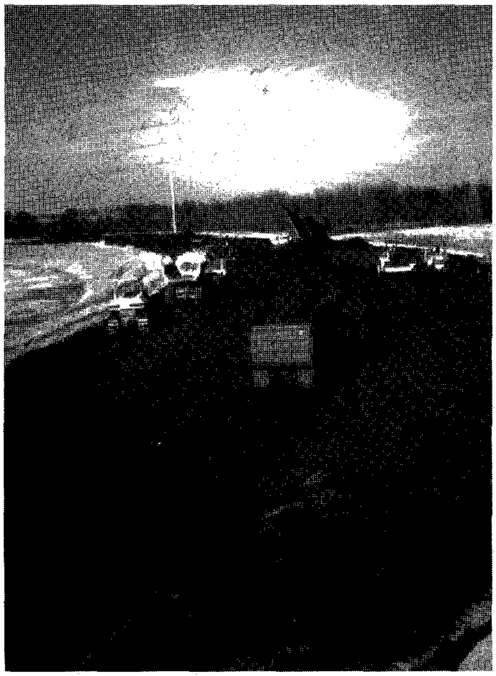

Figure 9. Part of the 250,000 tons of fly ash used in a structural fill for the ramps at the southern end of the by-pass around Suffolk.

ash-pellet reefs more economically feasible by reducing the cost of production through substitution of alternative stabilizers for the portland cement and quality control of the pellets.

In late 1996, Michigan Technological University's Institute of Materials Processing developed a new carbon-recovery technology that would transform coal ash, by removing the carbon into a useful mineral filler and the remaining ash recycled into concrete and other products (Industry Newswatch, 1996). This is important because the Clean Air Act Amendment of 1991 required coal-burning facilities to reduce carbon dioxide and other air emissions, which, in turn, led to increased levels of carbon in the ash and made it unsuitable for cement and concrete manufacturers. Mineral Resources Technologies (MRT) in Georgia is attempting to transform coal ash into a higher value mineral-filler product that can be recycled into concrete and other products. Their plans are to commercialize the technology by developing the operating facilities across the country. At the present time, this technology is not being used in Virginia (D. Bendein, 1998, personal communication).

FGD PRODUCT

Flue gas desulfurization (FGD) is a scrubber system, where finely ground limestone, wet or dry, is injected above the combustion zone and captures the sulfur from the burning coal. With the removal of sulfur, a FGD product is produced and collected at the base of the boiler. The Environmental Protection Agency has concluded that a flue gas desulfurization residue in the form of "synthetic gypsum" does not exhibit hazardous characteristics. There were about 24.6 million short tons of FGD material produced in the United States in 1999 (ACAA, 2001, written communication).

Presently the major use (3,053,268 short tons) of FGD is in wallboard. Demand for wallboard has been growing by an average of 5 percent per year for the last 15 years, but has increased significantly over the past several years. Wallboard production reached 27 billion square feet in 1998. Contributing to this are more new, larger houses as well as wallboard demand for repair and remodeling has grown 34 percent over the past 5 years. The wallboard industry is expanding its FGD gypsum plant construction significantly (Kalyoncu, 2000). The use of FGD eliminates the expense of capital investment in opening or expanding gypsum mines. Ten new FGD gypsum wallboard plants are slated to start operation in 2000-2003. Kalyoncu (2000) notes that the 700 million-square-feet-per-year Alabama plant is using 100 percent FGD (about 500,000 tons per year) from Louisville Gas and Electric Company. Other uses for FGD gypsum, in descending tonnage, are in structural fills, in cement, in mining applications, and as "land plaster" to improve soil conditions for the peanut industry.

In the middle 1990s, ReUse Technology, Inc., in Rocky Mount, North Carolina, produced a pelletized FGD residue that made a spreadable calcium and sulfur-rich soil amendment (GYP SYN) or "land plaster" that enhanced the production of peanuts, sweet potatoes, Christmas trees, ornamental shrubs, and grasses. FGD residue was obtained from a local Cogentrix Energy, Inc. power plant and from LG Electric power plant in Altavista, Virginia. The residue consisted of fine powder consisting of calcium sulfite, calcium hydroxide, calcium sulfate, and fly ash. The company was also investigating FGD from plants in central Virginia for possible use. Residue was trucked to Rocky Mount, processed into BB-size granules and marketed in 40-pound bags, one-ton bags, and in bulk. The product supplies the essential nutrients of calcium (20%) and sulfur (8%) to the peanut plants without changing the pH of surrounding soils. Early successful field testing gave ReUse product acceptance into the marketplace and BUCKSHOT was registered in North Carolina as a by-product "land plaster' and as a registered fertilizer in Virginia (Figure 10). ReUse's process turned a potential disposal cost into revenue producing product for a few years (Sweet, 1998). In the late 1990s, these products have not been continually accepted by the public and the project has been disbanded.

Research and development activities have focused on improving FGD processes and finding new applications for the FGD product. Some countries, with space limitations, are being forced to find better solutions to flue gas emission problems. In the United States, research efforts in FGD are directed toward either decreasing the quantities of the reaction products or increasing their economic value. The cost for power plants to place FGD in landfills is $6 to $10 per ton and estimates for this material in the future could range from $20 to $25 per ton (Sweet, 1994).

Figure 10. BUCKSHOT, registered name of the calcium and sulfur-rich soil amendment for the peanut industry, North Carolina & Virginia.

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STATE GEOLOGIST RETIRES

After almost 39 years at the Department of Mines, Minerals and Energy, Division of Mineral Resources, with the last nine years in the leadership roll as State Geologist and Director, Stanley S. Johnson retired on January 31, 2002.

Stan's career started with the Division of Mineral Resources in 1963 after graduation from the University of Virginia where he earned a B.A. degree in Geology. His first activities at the Division were in the Economic Geology Section. He was promoted in 1970 to supervise and plan the activities of a newly created Geophysical Surveys Section. He helped pioneer the Division's gravity, aeromagnetic, and aeroradioactivity mapping programs, and initiated and managed the Division's observational seismology program. He was requested to take responsibility for the management and administration of grants, contacts, and cooperative agreements in 1983. With these new duties he was also made Head of Special Projects. In 1989, under reorganization he was made Manager of the Geologic Research Branch. During his time in research, he authored or co-authored over 40 publications in economic geology, geophysics, and geochemistry.

Under Stan's direction and leadership, the Division's focus was to provide basic geologic data that could be used in the decision making process—geologic mapping and mineral resources information. Major accomplishments were in building coal mine, oil and gas, and mineral resources databases and geologic mapping at 1:24,000 and 1:100,000 scales. In the geologic mapping program approximately 1,650 square miles were mapped at 1:24,000 scale, 14,950 square miles were mapped and compiled and 1,480 square miles were edited and published at 1:100,000 scale. A new state geologic map was compiled and printed in 1993 at 1:500,000 scale. In the mineral resources program approximately 8,500 former and current mineral extraction and exploration pits/mines were visited and located on 1:24,000 scale maps. The Division published over 100 formal publications on the geology, energy, and mineral resources in the Commonwealth.

A major shift was made during his tenure with the decision to go digital in the Division's activities for addition to the numerous databases, the digitizing of existing and current geologic maps were started and continues with major progress. The last two years saw the publishing of a major educational CD-ROM series with Radford University on the Geology of Virginia.

He is active in the Association of American State Geologists as well as the Society of Exploration Geophysicists where he has been Chairman of the Membership Committee (1982-83) and was a member of the Professional Affairs Committee (1980-88), served as the Society's Second Vice President (1986-87) and as General Vice Chairman of the 55th Annual International Meeting (1985), and the General Chairman for the 63rd Annual International Meeting (1993). Stan was President of the Potomac Geophysical Society (1980-81) and Secretary in 1979-80. Stan is active in the American Institute of Professional Geologists. He served as the AIPG Annual Meeting Chairman in 1989; as National Secretary (1986, 1987); as Chairman of the State Affairs and Registration Committee (1987); and received the Institute's Martin Van Couvering Memorial Award in 1989. He has also received two National Presidential Certificates of Merit from the Institute. He is a member of the Geological Society of America (Fellow Status), American Association of Petroleum Geologists, American Association for the Advancement of Science, Carolina Geological Society, and the Virginia Academy of Science.

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NEW STATE GEOLOGIST APPOINTED

C. R. (Rick) Berquist, Jr. received his B.E. degree in Information Engineering (Computer Science) in 1969 and M.S. degree in Geology in 1970 from Vanderbilt University. After 3 years as a Supply Officer in the U.S. Navy and 2 years graduate work in Geology at Florida State University, he began work at the Division of Mineral Resources in July 1975. He spent the next 3 years in the southwestern Piedmont of Virginia making detailed geologic maps. In 1979 he moved to Williamsburg and continued detailed and regional mapping in the Coastal Plain and eastern Piedmont. In 1986 he completed a Doctorate in Marine Science (Geology) from the Virginia Institute of Marine Science (VIMS), College of William and Mary. His work with offshore minerals, geologic mapping and other VIMS and USGS scientists led to the discovery of the Old Hickory Heavy Mineral Deposit in the Fall Zone of Virginia. From April to November 1992 he joined the VIMS faculty as an Associate Research Scientist. Rick is also a Research Associate and adjunct faculty with the Department of Geology, College of William and Mary. For the past eight years he has taught GIS, managed a program to convert paper geologic maps to digital (GIS), and managed a drilling program to support geologic mapping in eastern Virginia. He served on the Virginia Board for Geology from 1990 to 1994 and has been an officer of the Virginia Geological Field Conference. He and his wife Karen have played acoustic music that supports local contra dancing with the group FOAM (Friends of Appalachian Music) for the past 20 years. Karen works in the science libraries and teaches scientific writing to international graduate students at the College of William and Mary. Their daughter Susan graduated from William and Mary, is married to Mike Zickel, and manages the interpretive staff at Historic Saint Mary's City, Maryland. Their son Peter graduated from William and Mary and is currently a graduate student in Geology at Vanderbilt University.